APPLICATION OF COMMERCIAL RESOURCES TO MILITARY NEEDS FOR ELECTRONIC POWER SUB-SYSTEMS

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Abstract

To reduce the costs of military power supply and distribution systems, the Electronic Power Specification Standardization (EPSS) activities, supported and driven by coalitions of the industry, is developing two interrelated reference documents: 1) Specification Language, and 2) Building Codes. Specification Language imparts integrity to the power system specification process and the resulting products. Building Codes are based on available high-end commercial products, and indicate their expected performance. The EPSS strategy is to provide the rational for the commercial power supply manufacturers to conform to these developing industry standards. Military power supply users will be able to confidently select needed resources from the commercial suppliers that conform to these EPSS standards. EPSS is sponsored by the Open Systems Joint Task Force from the Office of the Secretary of Defense.

Overview

Across military and commercial market places and applications, electronic power systems perform the same basic service of providing regulated power required by the functional electronic systems. This basic service is an indispensable part of all electronics. However, high costs are an acute problem to the DOD and industry. The salient reason for this problem is the lack of a consistent broadly accepted set of standards that is applied in the development and application of electronic power systems. Specifically, this prevents "generic" product development and the resultant cost savings. By developing standards that are based on best commercial practices, the military industry and DOD can maximize the effective use of high-end commercial-off-the-shelf (COTS) products. The objective of the Electronic Power Specification Standardization (EPSS) activities is to develop the vehicles that enable the effective use of such products. Government and industry have been supporting and participating in the development of these vehicles. The EPSS strategy is to provide the rational and the incentive for the commercial power supply manufacturers to adopt these standards in describing their products. The standards will enable military power supply users to confidently select and utilize commercial-off-the-shelf (COTS) products conforming to the EPSS standards.

EPSS is developing two interrelated products: 1) Specification Language, and 2) Building Codes. Specification Language development began in 1997. The development has been driven by the EPSS Working Group, which is comprised of industry personnel. This Group developed the draft IEEE P1515 document that is currently undergoing the balloting process leading to an IEEE standard. IEEE P1515 is scheduled for final approval in March 2000. Building Codes development began in Q4 1998 and has been a separate effort performed by the EPSS Consortium. The Consortium's work is in preliminary draft condition. Since these two activities are complementary, many EPSS contributors have

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participated in the development of both documents.

The EPSS activities are sponsored by Open System Joint Task Force (OS-JTF)[1] from the Office of the Secretary of Defense. The DOD's Open Systems Architectures/System Engineering Process is driven by an integrated technical and business strategy. The EPSS goal conforms to that of OS-JTF, that is to reduce systems acquisition costs through advancing the use of commercial-off-the-shelf (COTS) standards, products, services, and processes. Both DOD and the Institute of Electrical & Electronics Engineers (IEEE) have recognized the benefit of developing an electronic power specification standard, and are actively supporting the EPSS activities. Power Sources Manufacturers Association (PSMA) also has a forum for Government and Industry to address problems such as those that are being addressed by EPSS.

EPSS Standards

Presently the focus of the EPSS activities is on electronic power systems for digital and low-power RF electronics. The range of power systems covered includes single phase and three phase systems, with power levels up to 20KW, voltage levels up to 600 V, and frequencies up to 1 kHz. However, this language can be applied to systems outside this range.

Specification Language

Specification Language, in the form of IEEE P1515 Recommended Practice for Electronics Power Distribution Systems, contains definitions, test methods and test conditions for the parameters used to characterize power products. Use of Specification Language: 1) enables manufacturers to unambiguously specify their products based on EPSS definitions, test methods and test conditions, and 2) increases the confidence level of the potential users to select the products of the conforming manufacturers. By applying the Specification Language, manufacturers can reliably specify their products as tested to the EPSS specified test method and test condition. The objective is to have the parametric features to be defined and tested in the same way and under the stated conditions across all contending manufacturers. This standard method of product definition and characterization imparts integrity to the conforming products. Users can purchase conforming products with the confidence that parameters were tested using the conforming test methods and conditions. Manufacturers will have the basis to specify their products, test methods, and test conditions in order to have a conforming product.

Specification Language was considered to be a good starting point for the EPSS activities since it is difficult to compare products that are specified and tested differently. Different manufacturers specify power products differently. For example, different performance parameters are referred to using the same descriptor. Also, performance testing is done in different ways and under different conditions. The P1515 Specification Language provides corresponding definitions, test methods, and test conditions that if used, can enable product consistency among manufacturers.

Building Codes

Power supply architecture can be modeled as shown in Fig.1 Power System Architecture. Building Codes only address the boundary between the electronic power system and its external surroundings. The power system is considered a "black box" whose internal contents are of no concern to the EPSS architectural model. The boundary must be defined such that under a set of specified inputs, outputs can be predicted. The boundary, as depicted in the model, is divided into four interfaces: electrical, mechanical, environmental, and system effectiveness, see Fig. 2 Power System Interfaces. Each interface can be defined by a set of parameters.

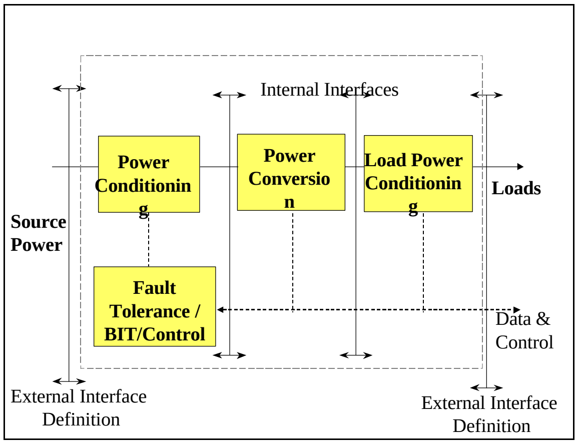

Fig.1 Power System Architecture

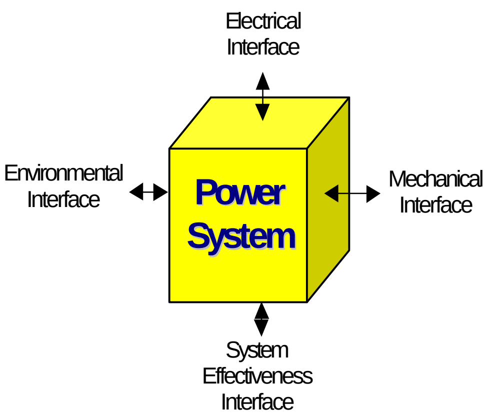

Fig. 2 Power System Interfaces

For example, the electrical interface has parameters for Vin, Vout, Voltage Ripple, etc. Each parameter is constrained by "common sense" rules or Building Codes that are based on the capabilities of available high-end commercial products. For example, the electrical interface parameter "input voltage" might be constrained to commonly available input voltages, including but not limited to 12Vdc or 115Vac.

The objective of the Building Code development is to identify and compile the capabilities of available high-end COTS power system products. A set of Building Codes will allow the military power system designer to select from the commonly available products, to optimally meet the system requirements. Commercial producers, with the knowledge of the typical military power usage, could tailor their specifications to conform to EPSS.

Application of EPSS Standards

A scenario describing the use of EPSS products begins with a power engineer tasked with configuring a power system for a digital rack. The digital card designers determine power requirements for the digital rack equipment. Requirements include input and output voltages, power required at each voltage level, acceptable amounts of electrical noise, and other information that has been referred to as electrical parameters and Building Codes. Systems engineering allocates a location and volume available for the power system in addition to other pertinent mechanical, system effectiveness, and environmental parameters and Building Codes.

The power engineer can then perform a make or buy analysis for a power system configuration that meets the requirements of the digital rack system. As part of the make or buy analysis, power products from various manufacturers, specified to EPSS standards, are considered. Comparisons can be made with the confidence that the competing products have been specified in the same way imparting process and product integrity. Any manufacturer's product, in conformance to EPSS, that meets all the requirements for the digital rack power system may be selected. If no product meets all requirements, the power engineer can request that the digital and system engineers reassess the requirements. It is possible that the requirements are needlessly restrictive. It may also be possible to accommodate a product that is "close" to meeting all requirements. For example, unusual voltage requirements may be met by putting an on card converter on the digital card rather than requiring the unusual voltage as an input to the digital card. When a product is found that meets the requirements, or can be accommodated to meet the requirements, the product can be purchased based on price, availability, or other relevant market

conditions. It is assumed that not all applications will be able to use EPSS conforming products. Unusual requirements, harsh environments, or unusual shapes will continue to require custom designs.

Power product manufactures need not modify their products to conform to EPSS Specification Language. The task for manufacturers is in the testing and reporting of data. EPSS only requires that manufactures describe their products in a standard way. For example, Output Voltage Ripple[2] (from P1515) is specified as follows:

4.5.1 Output Voltage Ripple

4.5.1.1 Definition: The maximum ac voltage component present on a dc or much lower frequency voltage stated in peak to peak voltage. The intent is to characterize the residual component associated with the switching action at switching frequency (or 2 times at switching frequency) (see Figure 1).

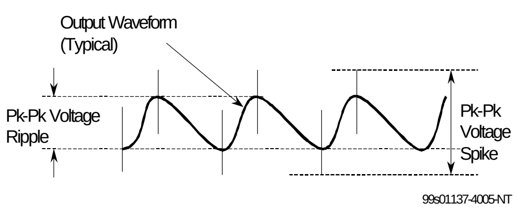

Figure 1. Typical Output Voltage Ripple and Spike

4.5.1.2 Test Method: Connect the test setup shown in Figure 2. Use an oscilloscope with a differential input amplifier and measure differentially between the plus and minus output terminals of the UUT. Make sure the UUT is isolated from any other conducting surface.

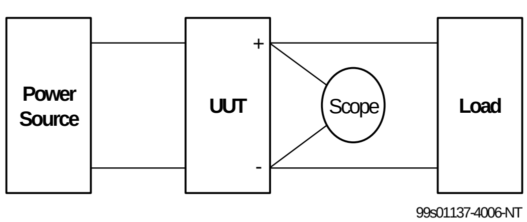

Figure 2. Output Voltage Ripple Test Setup

4.5.1.3 Test Condition: The baseplate temperature should be from minimum to maximum; the input voltage should be V_{min}, V_{nom}, and V_{max}; the load should be resistive, and should be I_{min}, I_{nom}, and I_{max}. The bandwidth of the scope should be at least 10 times the switching frequency.

Data sheets shall report the test results for EPSS parameters as well as the test methods and test conditions used. In the above example, under the test conditions described, the manufacturer specifies the input voltages as V_{nom}, V_{min}, and V_{max}, the load currents as I_{nom}, I_{min}, and I_{max} and the amount of Output Voltage Ripple measured under those conditions. The power engineer can then evaluate the competing products based not only on the data but also on the voltage and load conditions under which the data was obtained.

Building Codes give the military designers a guideline to the performance levels available in high-end commercial products. Using the above example for Output Voltage Ripple[3], the Building Code might be:

7. Voltage Ripple:

1% p-p Vout 5V to 50V @ switching frequency
2% p-p Vout <5V @ switching frequency
BW<20MHz

The power engineer can decide if this is sufficient for the power system he is selecting. Manufacturers have the option to design their products to Building Codes specifications knowing that there are military uses for products specified to these standards.

Conclusion

The power distributions system is an indispensable part of any functional electronic system. However, the cost of ensuring the availability of custom designed power systems is an acute problem for the military industry. This problem is due in large part to the lack of responsive and broadly accepted industry standards for the development and use of power parts, products and systems. The industry driven EPSS effort is striving to resolve this problem by developing two interrelated vehicles/standards (Specification Language, Building Codes). These standards are based on use of COTS high-end products.

EPSS Working Group and Consortium members are attempting to create a WIN-WIN situation benefiting both power system manufacturers, and commercial and military consumers of these power systems. The Specification Language used in conjunction with the Building Codes: 1) enables power system manufacturers to unambiguously specify and characterize their products, and 2) increases the confidence level of power system users when selecting products from conforming manufacturers.

EPSS Specification Language contains definitions, test methods and test conditions for the parameters used to characterize power products. By using an industry developed and agreed upon Specification Language, as opposed to each manufacturer specifying and testing products using their respective in-house methods, product specifications are imparted with integrity as to predicted performance.

Building Codes are being developed specifically for military users of power products as a way to inform them about available high-end COTS products. Only the interfaces between the power system and it's external surroundings are of concern in Building Code development. The internal workings of the power supply are left entirely to the manufacturer. Building Codes allow the power system consumer to select from available products, that meet the system requirements. By having EPSS standards any conforming product that meets all the requirements, or that can be accommodated by the target system, can be selected. At this time the focus of the EPSS activities is on power systems for digital and low-power RF electronics, although the scope includes all electronic power distribution systems.

It must be stressed that power product manufactures need not modify their products to conform to EPSS Specification Language. Manufacturers need only test and specify their existing products, according to the EPSS specified test methods and conditions.

References

1. Sergio Navarro, Carlos Gonzalez, and Marvin Soraya, " Electronic Power Specification Standardization," WEB posting, October 1997, http://www.acq.osd.mil/osjtf/standards3.html
2. Excerpted from IEEE P1515/D2.0 Draft Recommended Practice for Electronics Power Distribution Subsystems: Parameter Definitions, Test Conditions, and Test Methods, Section 4.5.1, Output Voltage Ripple
3. Excerpted from Draft Building Codes for Electronics Power Distribution Subsystems, Table 2: Electrical Interface: Output/Load Building Code – Single Output